

symptoms of kidney failure appear, and death results from kidney failure.

The person giving first aid should recognize the probability of crush syndrome from the position in which he finds the victim. He should, as far as he is able, prevent the absorption of muscle protein into the circulation by the application of a tourniquet. He should then note, on the identification tag, the history of a crushing and compression muscle injury. That the victim does not show any symptom of vascular shock should be no excuse for failure to apply a tourniquet, or to make the notation on his identification tag.

This history of a sustained crushing injury is of the utmost importance to the attending physician at the receiving hospital. Regardless of primary shock, the attending physician should take all precautions against the possibility of the appearance of the crush syndrome, recalling that it is a toxic condition of the kidney resulting from rapid absorption of toxins from the ischemic crushed muscle. By the use of the tourniquet in applying intermittent pressure, he should restore the blood supply and retard the absorption of the toxin.

Primary shock should be dealt with promptly by injecting plasma. Blood pressure and blood volume should be restored. The victim who may be subject to crush syndrome will stand a far better chance of recovery if all primary shock has been cared for adequately.

When the peripheral arterial pulse has disappeared, multiple incision into the tense edematous tissues may be indicated as a means of saving the limb. Early amputation should be done when it becomes evident that the circulation cannot be reestablished. The patient may have injuries apart from the crushing of muscle tissue, and which may require special attention. We may help to prevent secondary shock by giving morphine for relief of pain, by splinting fractures and controlling hemorrhage.

Whether surgery has been performed or not, whether primary vascular shock has been present or not, the victim should be watched and treated with the awareness of the possibility of crush syndrome. The syndrome may begin to appear within a few hours after admission to the hospital or at any time within forty-eight hours. The rising acidity of the urine, with its typical red tinged casts and albumin, and the rising blood pressure, and the closing down of urinary secretion are indicative of kidney involvement.

Preventative measures should be begun promptly. Alkalinization of the urine is important. Alkalis should be given until the urine remains alkaline to litmus. Methyl red should be used, however, to detect the degree of acidity. If the urine cannot be made alkaline to methyl red, the prognosis is grave. Intravenous alkalis may be necessary to maintain an alkaline urine. Five per cent sodium bicarbonate solution intravenously, as used in the last war, may be employed in order to maintain an alkaline urine.

Fluids should be given for the purpose of maintaining the water balance of the body, that

it may offer sufficient water for dilution of the muscle toxin in the secretion by the kidney, but not enough that it may cause edema of the crushed muscle.

Normal saline or dilute glucose (5 per cent solution) are contraindicated because, in the presence of a highly acid urine, either will tend to cause edema. A hypertonic solution of 2 per cent magnesium sulphate or 15 to 20 per cent glucose solution are to be preferred for their dehydrating effect on the swollen kidney. The kidney, swelling within its capsule, tends to compress its own blood supply, thereby doing additional damage to that already present. Solutions given should tend to prevent edema of the kidney.

Plasma should be given with the idea of sustaining the blood volume. Too much plasma, especially when the blood pressure is normal or is beginning to rise from damage to the kidneys, may be dangerous in that it will hold the water against kidney excretion.

The blood chemistry of the crush syndrome shows at its very beginning a rise in the N.P.N., and frequent laboratory checks of the N.P.N. may greatly help in the detection of an oncoming crush syndrome.

COMMENT

With a stepping up of bombing incidents, we would expect more crushing injuries among the civilian population, and an increase in the number of cases presenting the crush syndrome. Such injured person should be carefully watched, and shock and kidney damage should be forestalled. If evidences of beginning shock or kidney damage appear, antishock treatment should be instituted promptly and the kidneys protected against damage by retarding entrance of toxins into the blood by use of a tourniquet, by alkalization, and by giving fluids to maintain water balance.

S. P. Hospital, Fell and Baker Streets.

CHEMICAL WARFARE AGENTS: CASUALTIES THEREFROM*

DAVID A. RYTAND, M. D.
San Francisco

THE agents which have been used in chemical warfare may be separated into a half-dozen groups, according to their effects on the body. Of these, lacrimators and sternutators require little or no medical care because of the short duration of their action; while serious, the main systemic poisons cause syndromes with which physicians have become familiar in civil practice. Moreover, tacticians do not expect the enemy to use lacrimators, sternutators or systemic poisons against civilians in this country.

If the enemy comes, however, he may be expected to bring incendiaries, lung irritants and vesicants. A knowledge of the general aspects of

* One of several papers in a Symposium on "Emergency Medical Service in Wartime." Papers collected by Henry Gibbons, III.
From the Department of Medicine, Stanford University Medical School. This work is based on Civilian Defense publications.

chemical casualties due to these agents is of the utmost potential importance.

1. *Lacrimators:*

The chief action of tear gases is a prompt but transient irritation of the eyes, with lacrimation, photophobia and blepharospasm. Leaving the gassed area, the victim may obtain relief on facing windward with open eyes, which should not be rubbed. The need for medical attention is small; therapy consists of irrigation with warm saline or freshly-prepared 2 per cent solution of sodium bicarbonate. Later, sterile glycerine or boric acid ointment may be used.

2. *Sternutators:*

These agents cause a longer lasting irritation of the upper airway and paranasal sinuses, with vomiting, sneezing, and violent headache leading to mental depression. Sedatives, acetyl salicylic acid or related analgesics, and assurance of an early recovery are of prime importance. The nares may be sprayed with saline, 2 per cent solution of sodium bicarbonate or the following:

Neosynephrine hydrochloride 1%....	4.
Pontocaine hydrochloride04
Boric acid saturated solution.....	12.

3. *Systemic Poisons:*

(a) Hydrocyanic acid poisoning is treated by artificial respiration and intravenous injections of methylene blue (50 cc. of 1 per cent methylene blue is isotonic solution).

(b) Arsine causes an acute hemolytic anemia, treated directly by transfusions of whole blood or red cell mass and inhalations of oxygen. Sodium bicarbonate in large doses by mouth may prevent precipitation of hemoglobin in the renal tubules with consequent uremia; for the same reason, urine output is to be maintained at a high level by the use of oral and parenteral fluids.

(c) Carbon monoxide is formed during explosions and settles into bomb craters; treatment includes artificial respiration with inhalation of oxygen and carbon dioxide, transfusions of whole blood or red cell mass, and measures against shock.

4. *Incendiaries:*

Therapy of thermal burns must be directed not only to the local wound, but with extensive injuries to the individual as well.

In this restricted space, it is not possible to discuss the features of the many methods advocated for local treatment of burns. Most agree that greases and oils are to be avoided as first aid measures, but from there on the physician has a wide latitude of choice. For minor burns, sterile vaseline, triple dye, or a sulfonamide in aqueous jelly have been recommended. For more severe injuries, one of the best methods is that of pressure dressings with sulfathiazole or boric acid ointment; sodium sulfadiazine may be given intravenously to combat infection, while tetanus antitoxin may be used if indicated. Full aseptic technique should be carried out while dressing burns.

With severe burns, shock is present; its management is outlined in an accompanying discussion, with the notation here that, since hemorrhage is absent, plasma is preferable to whole blood.

Once past the immediate dangers, attention must still be given to both local lesions and the patient himself. Skin grafts and the prevention and treatment of contractures are in order. Hypoproteinemia and a state of general malnutrition may supervene unless care is taken to insure an abundant intake of food with particular emphasis on protein; of the vitamins, thiamin and ascorbic acid are most useful.

During war, thermal burns may be inflicted upon civilians fighting fires started by incendiary bombs; these contain white phosphorus. Wounds in which particles of phosphorus are present should be flooded with water at once, and the phosphorus removed while the wound is under water. A 2 per cent solution of copper sulfate is said to be helpful by the formation of an insoluble coating of copper phosphide. In further local treatment one proceeds as with thermal burns; escharotics are contraindicated. Bits of phosphorus in the eye are to be washed out immediately with water, following which 0.5 per cent pontocaine ointment and a dressing may be applied.

5. *Pulmonary Irritants:*

Chlorine and phosgene produce pulmonary edema, necrosis of tissue and thrombosis of the small pulmonary vessels. After a slight reflex irritation, which may or may not occur at the moment of exposure, there follows a latent period during which the development of lesions is silently taking place. The first symptom is restlessness, followed by a vague sensation of oppression. Anoxemia soon leads to cyanosis, and accumulation of carbon dioxide adds to dyspnea. By this time, cardiac and respiratory rates are rapid, râles appear, coughing produces watery sputum, and the neck veins are full; shock occurs much later, bronchopneumonia may complicate the picture. If the patient recovers, pulmonary fibrosis or other complications are very rare; statistics show no increase in pulmonary tuberculosis in those gassed by lung irritants in World War I.

Treatment is directed at anoxia and dyspnea, shock, and complicating infection. Once symptoms appear, complete rest is essential; this reduces blood flow through the throttled pulmonary vascular tree and decreases the need for respiratory movements. It is no longer thought that bodily activity need be stopped at the moment of exposure. For the respiratory symptoms, injections of morphine and atropine, and inhalations of oxygen without carbon dioxide are most useful; intravenous injection of aminophyllin has been recommended in addition. Artificial respiration is contraindicated. Because of the distended jugular veins with dyspnea, there may be a temptation to remove blood; this should not be done, for shock is present or impending. Furthermore, the pulmonary lesions modify measures against

shock, in that plasma must be given cautiously and the head-down position may embarrass respiration.

The immediate danger is over after 48 hours, when the pulmonary lesions may be complicated by pneumonia; sulfonamides should be given as one would for lobar pneumonia.

If a wound necessitates operation under anesthesia in a patient injured by a pulmonary irritant, inhalation and spinal methods should be replaced by field block or local anesthesia.

6. Vesicants:

The main action of the mustard "gases" and of Lewisite is the production of severe inflammation of skin and eyes. Prevention of this effect by energetic first aid or, better, self help is of utmost importance.

Since one has only a few minutes to remove or neutralize these agents, *speed* in carrying out a predetermined plan is essential. Remove the victim from the contaminated area and his clothes from him. If exposure to the liquid form of the mustard or Lewisite has occurred within five minutes, wash the eyes thoroughly with freshly prepared 2 per cent solution of sodium bicarbonate (heaping tablespoonful per quart of *warm* water) if available at once; tap water is preferable in case of delay. In the event of exposure to vapor, or to liquid vesicant prior to five minutes, lavage of the eyes is useless and may even be dangerous. Next, blot without rubbing any excess vesicant from the skin, disposing of the used absorbent cotton or toilet tissue to prevent other burns.

Neutralization of the agent follows. Logically, one should identify the vesicant in order to select the best neutralizing substance. This takes time, and, after all, neutralization is only one step in the prevention of lesions. Household bleaching solutions (clorox or purex) of hypochlorite are effective at least against mustard (alone or mixed); pat on the contaminated skin surfaces, but do not use on the eyes.

Finally, and most important, wash carefully in a shower with plenty of lather and water. Dry without rubbing, and clothe.

To summarize self help: (1) remove the victim from the gassed area and his clothes from him, (2) wash the eyes (if very recently exposed to liquid vesicant) with water or fresh weak sodium bicarbonate solution, (3) blot off excess vesicant, (4) neutralize with household bleaching solution, and (5) shower with abundant lather and water.

The directions given above should be memorized by all civilians for their own use, and may be carried out by physicians working in decontamination stations.

Once the vesicant has injured the skin, the patient and his wounds are treated as for thermal burns. Hypochlorite is not used after erythema appears; blisters need not be opened to remove hypothetical toxic agents. No oil, neutralizing agent or tight bandage should ever be applied to affected eyes; for pain, 0.5 per cent pontocaine

(not cocaine) solution is helpful, and 1 per cent atropine should be used against miosis. Photophobia requires dark glasses. Later, boric acid ointment or sulfathiazole ophthalmic ointment may prevent or treat secondary infection.

Clay and Webster Streets.

WOUNDS: THEIR CARE UNDER CIVILIAN DEFENSE*

JOHN HOMER WOOLSEY, M. D.

Woodland

WOUNDS obtained under conditions of bombing, explosions and gunfire vary from abrasions to severe contusions, with at times great tearing and rupture of tissues and shattering of bones. It is important, therefore, that each responsible physician be informed as to the nature of these injuries, and have a well thought-out plan how he will proceed promptly, and in an orderly manner, to render the best care possible under any given circumstance.

Wounds will, therefore, be discussed under the headings: their nature, the rôle of devitalized tissue, bacteriology and treatment.

NATURE OF WOUNDS

Abrasions are no different than those of civil injury, except possibly for greater contamination.

Wounds of the soft tissues, due to great and sudden forces or to a crush from falling timbers or walls, have a more widely-distributed injury. There is also the chance of greater contamination due to such a high proportion of wounds being caused by secondary objects as glass, wood, masonry, etc. This leads to devitalization of tissue upon which microorganisms may live and develop, or to rupture of blood vessels with hemorrhage, furnishing thereby a nidus for infection. *The devitalization of tissue and contamination are the factors of primary importance.*

The contamination of wounds, under conditions associated with civilian defense in a war zone, forces us to consider wounds in their two main stages—that of contamination and that of infection. Contamination is that stage where the bacteria are upon the surface and not as yet proliferative; whereas infection is the stage where bacteria have invaded the tissues and proliferation is occurring.

The stage of contamination may exist up to twelve hours, but preferably should be considered up to six or eight hours. The degree of contamination varies, dependent upon the location in or out of a building, a heavily-cultivated soil, a sandy loam or paved street, the condition of the weather giving a dry warm dust or a muddy contamination of objects and clothing; the portion of the body involved, for example, the clostridia are more common about the lower extremities, especially the thigh; and the type of cleanliness

* One of several papers in a Symposium on "Emergency Medical Service in Wartime." Papers collected by Henry Gibbons, III.
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